

REMARKS/ARGUMENTS

In response to the Office Action dated March 16, 2005, Claims 1-87 remain in this application. Claim 51 has been amended to correct a minor typographical error only.

Claims 1, 5-10, 12-14, 30, 35, 45, 46, 55-58, 86, and 87 were rejected under 35 USC 102(b).

Claims 11, 15-29, 31-34, 37-44, 70-72 and 79-80 were rejected under 35 USC 103(a).

Claims 2-4, 36, 48-54, 59-69 and 73-78 were objected to as being dependent upon a rejected base claim.

Applicants gratefully acknowledge the Examiner's indication of the allowability of the subject matter of Claims 2-4, 36, 48-54, 59-69, 73-78 and 81-85.

Claim Rejections - 35 USC § 102

Claims 1, 5-10, 12-14, 30, 35, 45, 46, 55-58 and 86 and 87 are rejected under 35 USC 102(b) as being anticipated by Chen et al. (US Pat. No. 6,139,697).

The rejection under 35 USC 102 of Claims 1, 5-10, 12-14, 30, 35, 45, 46, 55-58, 86 and 87 over Chen et al. is respectfully traversed because Chen et al. has nothing to do with ion implantation nor plasma immersion ion implantation and lacks elements of Claim 1.

Apparently, the Examiner mistakenly relies upon Chen et al. Column 7 lines 20-35 as disclosing plasma immersion ion implantation. The Examiner's belief in this is probably due to Chen et al.'s disclosure that the PVD Cu layer integrates into the underlying CVD Cu layer during the PVD deposition, and that the PVD Cu layer contains Sn, which is referred to by Chen et al. as a "dopant". This process is not ion implantation but rather a deposition process in which material from the deposited layer (the PVD Cu layer) happens to diffuse or migrate into the

underlying CVD Cu layer. The Examiner probably assumes that this diffusion process carries some of the Sn "dopant" with it, but Chen et al. is silent on this point. This fails to meet the description of "ion implantation": There is no showing in Chen et al. that the integration of the deposited PVD Cu material into the underlying CVD Cu layer involves any ions or any ion bombardment. In fact, it does not. **There is no potential applied to the wafer or substrate in Chen et al. that would attract ions to the substrate** or impart sufficient energy to them for ion bombardment or implantation. Thus, it is clear that Chen et al. fails to disclose an ion implantation process, so that the rejection fails to meet the element of "implanting ions" of the claims.

Chen et al. fails to meet the combination of the claims (see Claim 1 for example) of "coupling RF source power" and "applying an RF bias from an RF bias generator **to said workpiece support**". There appears to be only a single RF generator in Chen et al, so that he cannot meet the dual limitation of the claims (e.g., Claim 1) requiring both source power and bias power. Moreover, the RF bias of Chen et al. is not applied to the workpiece or workpiece support (as required in applicants' claims) but rather to the sputtering target (i.e., the Cu target near the chamber ceiling). The sputter target of Chen et al. is not the semiconductor wafer on which Chen et al.'s PVD Cu layer is deposited. It would appear that, in fact, no RF is applied to the wafer or workpiece support in Chen et al.

Chen also fails to disclose the feature of the claims (see Claim 1 for example) of coupling RF plasma source power across the wafer (workpiece) and the ceiling or sidewall: "coupling RF source power across said workpiece support and said ceiling or said sidewall". In contrast, Chen et al. only teaches forming a plasma at the sputtering target, and is silent on the question of whether his wafer is also immersed in the plasma (as defined by

its sheath). Chen et al. applies his RF power across his sputtering target and the sidewall (see Chen et al.'s FIG. 6), in violation of the requirement of applicants' Claim 1 that the source power be coupled across the wafer or workpiece support and sidewall (or ceiling). The plasma at Chen et al.'s sputter target generates a vapor of (copper) atoms, a portion of which deposit on the wafer. This vapor may extend beyond the bounds of the target plasma in order to reach the wafer or workpiece, although Chen et al. is silent on this point. Hence the use of the term physical VAPOR deposition by Chen et al.

In summary, Chen et al. is unrelated to plasma immersion ion implantation because his RF power is only applied to a sputter target to generate a plasma at the sputter target, while applying no power to his wafer or wafer/workpiece support. Therefore, Chen et al. cannot meet the language of the claims (e.g., Claim 1) of (a) "implanting ions", (b) "coupling RF source power across said workpiece support and said ceiling or said sidewall" and (c) "applying an RF bias from an RF bias generator to said workpiece support".

With regard to Claim 5, Chen et al.'s bias level cannot determine an implantation depth because it is not applied to the workpiece or workpiece support (but rather to a sputter target). With regard to Claim 6, the underlying layer in the Chen et al. process of Column 7 lines 20-35 relied upon by the Examiner is not a semiconductor, but is rather a conductor (i.e., copper), for which Chen's so-called "dopant" cannot affect a conductivity type (p or n) because the underlying CVD copper layer and the deposited PVD copper layer are not a semiconductor.

With regard to Claim 7, Chen et al. does not disclose a process gas including a chemical combination of Chen et al.'s so-called "dopant" (Sn) and another element, such as fluorine (as in applicants' Claim 8).

Similarly, Applicant respectfully traverses all of the

remarks made in the rejection concerning the other dependent claims referred to in this rejection (Claims 9, 10, 12-14, 30, 35, 45, 46, 55-58, 86 and 87).

In view of the foregoing, the claims are not anticipated by Chen et al., and so withdrawal of the rejection of Claims 1, 5-10, 12-14, 30, 35, 45, 46, 55-58, 86 and 87 over Chen et al. under 35 USC 102 is respectfully requested.

Claim Rejections - 35 USC § 103

First Rejection: Claim 11 is rejected under 35 USC 103(a) as being unpatentable over Chen et al. (US Pat. No. 6,139,697) in view of Wu et al. (US Pat. No. 4,584,026).

Claim 11 contains all the limitations of the claims discussed above and is therefore distinguished from Chen et al. on the same basis. Wu et al. is concerned with ion beam implantation, not plasma immersion ion implantation, and therefore has nothing to do with the claims. Therefore, reconsideration and withdrawal of the rejection of Claim 11 is respectfully requested.

Second Rejection: Claim 47 is rejected under 35 USC 103(a) as being unpatentable over Chen et al.

Claim 47 contains all the limitations of the claims discussed above and is therefore distinguished upon the same basis. Therefore, reconsideration and withdrawal of the rejection of Claim 47 under 35 USC 103 is respectfully requested.

Third Rejection: Claims 22-25 and 70-72 are rejected under 35 USC 103(a) as being unpatentable over Chen et al. in view of Paton et al. (US Pat. No. 6,811,448 B1).

These claims contain the same claim language discussed above and are therefore distinguished from Chen et al. on the same basis. Neither Chen et al. nor Paton et al. concern plasma immersion ion implantation, and therefore these claims are unobvious over the cited combination of Chen et al. and Paton et

al. Therefore, reconsideration and withdrawal of the rejection of Claims 22-25 and 70-72 under 35 USC 103 is respectfully requested.

Fourth Rejection: Claims 26-29, 32-34, 37-44 and 79-80 are rejected under 35 USC 103(a) as being unpatentable over Chen et al. in view of Wolf (Silicon Processing for the VLSI Era; Vol. 1).

These claims contain the same limitations discussed above and are therefore distinguished from Chen et al. upon the same basis. Moreover, Wolf is concerned with ion beam implantation, not plasma immersion ion implantation (see Wolf, page 308), and therefore has nothing to do with the claims. Therefore, reconsideration and withdrawal of the rejection of Claims 26-29, 32-34, 37-44 and 79-80 is respectfully requested.

Fifth Rejection: Claims 15-21 and 31 are rejected under 35 USC 103(a) as being unpatentable over Chen et al. in view of Chung et al. (US Pat. No. 6,513,538).

Neither Chen et al. nor Chung et al. is concerned with plasma immersion ion implantation, and therefore the cited combination cannot render the claims obvious. Therefore, reconsideration and withdrawal of the rejection of Claims 15-21 and 31 over Chen et al. and Chung et al. is respectfully requested.

SUMMARY

In view of the foregoing correction and remarks, it is felt that the objections to the claims and the rejections of the claims under 35 USC 102(b) and 35 USC 103(a) have been overcome.

Therefore, withdrawal of these objections and rejections is respectfully requested and allowance of the application is earnestly solicited.

If, However, the Examiner believes that there are any unresolved issues requiring adverse final action in any of the claims now pending in the application, the Examiner should telephone Robert Wallace at (805) 644-4035 so that appropriate arrangements can be made for resolving such issues as expeditiously as possible.

Respectfully submitted,



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Robert M. Wallace
Reg. No. 29,119
Attorney for Applicants
Customer No. 000044843

Robert M. Wallace
Patent Attorney
2112 Eastman Avenue, Suite 102
Ventura, CA 93003
(805) 644-4035